DOCUMENT RESUME

ED 396 095 CE 071 504

AUTHOR	Prescott, Carolyn A.
TITLE	Education and Work: Toward an Integrated Curriculum Framework. A Report on the Integrated System for Workforce Education Curricula Project.
INSTITUTION	Center for Occupational Research and Development, Inc., Waco, Tex.
REPORT NO	ISBN-1-55502-855-1
PUB DATE	96
NOTE	35p.
AVAILABLE FROM	CORD Communications Inc., Customer Relations, P.O. Box 21206, Waco, TX 76702-1206.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Academic Education; Academic Standards; Articulation (Education); Consortia; *Curriculum Development; Educational Change; Educational Needs; *Education Work Relationship; *Integrated Curriculum; *Labor Force Development; Models; Position Papers; Postsecondary Education; School Role; Secondary Education; *Systems Approach; Thinking Skills; *Vocational Education

ABSTRACT

This paper describes the rationale, direction, and progress of the Integrated System for Workforce Education Curricula (ISWEC), a project sponsored by a 25-state consortium that is designed to accomplish two primary objectives: (1) integration of academic and vocational education in a curriculum framework for grades 9-14 and (2) development of a process through which educators can elaborate upon the framework to adapt it to their schools' needs and strengths. The following topics are discussed: rationale for integration, consensus about education and work; pedagogical advantages to integration; role of standards in the ISWEC project; rationale for a comprehensive curriculum project; purpose and content of an integrated curriculum standard (ICS); process of grouping ICSs into clusters and career majors; role of assessment in the ICS framework; technique for using ICSs to develop curricula; process being used to develop the ICS framework; and relationship between integration and higher-order thinking skills. Contains 13 references. Appended are sample integrated curriculum standards and a list of steps toward integration using work force, academic, and occupational standards. (MN)

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A report on the Integrated System for Workforce Education Curricula project

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Printed in the United States of America

ISBN 1-55502-855-1

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Acknowledgements

The Center for Occupational Research and Development (CORD) wishes to express gratitude to the following organizations for their support and contributions: Vocational-Technical Education Consortium of States (V-TECS), National Association of State Directors of Vocational Technical Education (NASDVTEc), Southern Region Education Board (SREB), and American College Testing (ACT).

The following states have signed grant agreements as participants in this project: Alabama—Department of Education; Arkansas—Department of Education, Vocational and Technical Education Division; Connecticut—Department of Education; Hawaii—Department of Education; Idaho—Division of Vocational/Technical Education; Kansas—State Board of Education; Louisiana—Department of Education, Office of Vocational Education; Michigan—Jobs Commission, Office of School-to-Work; Oklahoma—Department of Vocational and Technical Education; Pennsylvania—Department of Education, Bureau of Vocational Technical Education; South Carolina—Department of Education; South Dakota—Department of Education, Office of Adult, Vocational, and Technical Education; Tennessee—Department of Education, Division of Vocational Technical Education; Vermont—Department of Education; Washington—Superintendent of Public Instruction, State Board/Community and Technical Colleges, and The Boeing Company; West Virginia—Department of Education, Bureau of Vocational Technical Education; Wyoming, Department of Education

Education and Work: Toward an Integrated Curriculum Framework

The relationship between education and work has been a critical issue in the recent years of debate over school reform. Consider the divergent positions such as the desire to maintain the schools as bastions of individualistic thought and free inquiry, unfettered by economic needs and realities versus the desire to narrowly focus education to meet the most immediate and practical needs of industry. As these opposing views have been made explicit, polarization has given way to understanding. Today, many have come to see these positions as a continuum of thought rather than opposite extremes. The consensus is to help the nation's youth advance both academically and occupationally,[1] and to reach compatible goals.

The Integrated System for Workforce Education Curricula (ISWEC) is a project designed to link work and education in a meaningful and systematic way. The primary goals of the project are to integrate academic and vocational education in a curriculum framework for grades nine through fourteen and to develop a process through which educators can elaborate upon the framework to fit it to the needs and strengths of their schools. The ISWEC project was initiated in January 1995 and sponsored by a consortium of states, each represented by its director of vocational education. Twenty-five states have joined the consortium or are in the process of joining. The Center for Occupational Research and Development (CORD) is carrying out the work of the ISWEC project. CORD is at the center of a dialogue among the member states of the consortium, whose representatives have played a key role in shaping the project. Recently, the consortium expanded the network of participants through the formation of an electronic network, the Integration Assistance Network, whose members are acting as reviewers and contributors of ideas as the ISWEC framework is developed. A recent meeting of representatives of the network was instrumental in moving the project forward and clarifying the nature and development of the framework.

The purpose of this paper is to describe the direction of the ISWEC project. An earlier paper described the ideas and initiatives that led to the formation of the ISWEC consortium.[2] This paper will review the rationale for integration and the role of standards in the project. It will then describe the process being used to develop the ISWEC framework and the nature of the framework as it has evolved so far.

Why Integration?

It is widely recognized that students find meaning and motivation for their schooling when it is clearly linked to future work.[3] Heidi Hayes Jacobs cites students' need for clearly demonstrated relevance.[4] Gary Hoachlander, of Management Planning Research, and others have stated that work is a powerful "meaning-maker" for students. However, if work were only an *arbitrary* maker of meaning for the educational system, educators would feel less compelled to address workforce needs together with broader educational goals. The drive to address workforce education is a fundamental value of the culture and society, propelled by parents, employers, and many other sectors of the community.

What Is the Consensus About Education and Work?

Schools are caught in the cultural crossfire of society in large part because we expect them to transmit societal values—we have always expected them to do so—at the same time that we are in profound confusion and conflict about those values. In a time of economic uncertainty, technological challenges, and cultural crises, education is the repository for our hopes for, and ambivalence about, many different aspects of American life. Our ability to improve our schools may depend on our willingness to limit the terms of our expectations for schools to areas of widespread agreement. The belief that we need to educate our children in a way that relates to work and benefits them and their employers throughout their working lives—but without sacrificing their capacity for broader learning and understanding of the world—is indeed central and shared by many different interest groups.

In the past, a dual system of vocational and academic education evolved in our nation's schools. This dual system has been hierarchical and fragmented: It has separated and privileged head skills over hand skills—abstract learners over concrete learners; it has emphasized work goals for one group and neglected them for another. By contrast, the new shared vision is one of integration of vocational and academic education.

What Are the Pedagogical Advantages to Integration?

In addition to the growing societal consensus that academic and vocational education must be integrated to create meaningful, work-related system of education, evidence that integration makes good sense pedagogically exists. Humans learn by connection-making,[5] and so the shift from schooling in isolation to schooling in relation to the workplace and other life experiences has the potential to improve instruction. The motivational aspects of designing curricula that prepare students for work and the future were mentioned previously. In addition, experiential approaches to learning long associated with vocational education are being recognized as effective with all students.

Contextual, hands-on approaches to teaching physics, biology and chemistry, and mathematics were developed by CORD beginning in the 1980s and have been used successfully in many Tech Prep programs and some academic programs across the country. This approach encourages many different forms of learning in context, such as:

1. **Relating**: learning in the context of life experience.
2. **Transferring**: learning in the context of existing knowledge—using and building upon what a student already knows.
3. **Applying**: learning in the context of how the information can be used.
4. **Experiencing**: learning in the context of exploration, discovery, and invention.
5. **Cooperating**: learning in the context of sharing and communicating with other learners.[6]

Once students are exposed to classroom environments in which they can succeed, it does not make sense to place these students back into the traditional courses in which they previously struggled, and all too often failed.

A recent report by the National Center for Research in Vocational Education (NCRVE), *Teaching for the Transfer of Learning,* documents and describes the use of interdisciplinary and cross-disciplinary strategies in teaching and learning. Not only do such approaches succeed in educating students in such a way that they can apply their knowledge and skills to new and unfamiliar situations, they also result in higher retention within the separate content areas treated.[7] A whole body of recent cognitive research tells us thinking skills can be taught,[8] and they appear to be most effectively taught when attention is drawn to how thinking skills are used to solve a variety of particular practical problems and to analyze a variety of real-life situations.

Integration of curricula also addresses larger problems related to the growth and specialization of knowledge. The proliferation of information poses a dilemma for educators in terms of sheer volume. The traditional boundaries among the academic disciplines and occupational cluster areas tend to foster fragmentation; they do not always allow for a meaningful approach to learning skills and knowledge in context. Even as more teachers incorporate contextual instructional strategies into their individual classrooms, problems of fragmentation and redundancy remain. Fragmentation in the classroom translates into overspecialization in the workplace, which in turn can result in fragmentation of effort, lack of cooperation, and decreased productivity. A systematic approach to integration of academic and vocational education can reduce duplication of educational effort and establish commonalities among academic disciplines and workforce requirements.

What Is the Role of Standards in the ISWEC Project?

The role of standards in the integration of vocational and academic education is critical. Standards are the subject of numerous controversies: At stake are who should set standards; whether standards should be established at the national, state, or local level; and what degree of specificity and scope standards should reflect. Despite, or perhaps because of, these questions, standards have come to the center of school reform debates. Moreover, standards are serving the educational community well in many ways, even as their validity and importance are being examined. Standards are forcing school reform debates to be carried out in more concrete terms than previously. Standards are separating issues of educational content—what is taught—from issues of educational methodology—how it is taught. Standards are clarifying the positions and interests of various stakeholders in the education of children and youth.

The consensus that our schools need standards has become clear. The policy statement issued at the conclusion of the 1996 National Education Summit asserts that the use of standards will accomplish the following:

- help all students learn more by demanding higher student proficiency and providing effective methods to help students achieve higher standards;

- provide parents, schools, and communities with an unprecedented opportunity to debate and reach agreement on what students should know and be able to do;
- focus the education system on understandable, objective, measurable, and well-defined goals to enable schools to work smarter and more productively;
- reinforce the best teaching and educational practices already found in classrooms and make them the norm; and
- provide real accountability by focusing squarely on results and helping the public and local and state educators evaluate which programs work best.[9]

These and other benefits have led to the agreement that for the educational system to work, it is necessary to have clearly articulated expectations for what learners must know and be able to do.

Notwithstanding the agreement on the use of standards, the number and diversity of standards that are coming to bear on the educational system are initially bewildering. Standards have been developed by various national groups representing the academic disciplines as well as some state groups. The national groups include the American Association for the Advancement of Science; the National Science Teachers Association, the National Council of Teachers of Mathematics, and many others. The academic standards vary in their specificity; they also vary in the degree to which they address knowledge content, higher-order thinking skills, and attitudes toward learning.

Workforce standards have been developed under the auspices of the National Skill Standards Board and funded by the United States Departments of Education and Labor. The twenty-two sets of skill standards, while not comprehensive, provide industry-validated standards in a range of occupations. The skill standards were developed by teams made up primarily of employers, so they provide a business-industry perspective. Like the academic standards, the workforce standards vary—in the specificity of tasks and the degree to which they address knowledge content, higher-order thinking skills, and attitudes toward work. Among some of the various workforce standards, similar and even identical tasks and competencies can be found. In the areas where workforce standards have not been developed, the ISWEC project has incorporated data from the Vocational-Technical Consortium of States (V-TECS).

General employability standards have been identified by several agencies and organizations. Chief among them are those developed by the Secretary's Commission on Achieving Necessary Skills (SCANS). Other employability standards are the High Performance Workplace behaviors that have been tentatively identified in the National Job Analysis study, to be completed later this year. Employability standards identify skills that cut across all occupations. They also tend to reflect a higher level of performance than can be expressed when job tasks are enumerated without elaboration.

Each set of standards described above can be seen to represent a legitimate part of the educational process. Each represents the interests and priorities of different stakeholders in the education system. However, educators must still decide what standards to incorporate, for which students, in what sequence, and in what manner. If one accepts the premises stated earlier that a dual-track system of education is unacceptable and that all students' education needs to be relevant to future work, some of the questions begin to be answered, but a great deal of work still needs to be done.

As pointed out in *Revitalizing High Schools*, it is easier to assert what standards should be avoided—"separate academic and occupational standards at the secondary level"[10]—than to determine what kind of standards should be implemented. A guide to integration recently developed by NCRVE guides teachers and other educators to examine academic, workforce, and employability standards together and to group them in the development of learning activities. The ISWEC project is congruent with this line of thought; it is undertaking the combination of workforce, academic, and employability standards.

The integration of the three kinds of standards is based on the recognition that standards-based reform is a key element in systemic change in education, yet the use of a single type of standard as the basis for curricula will only perpetuate the ineffective division between knowledge and its practical application.

Why a Comprehensive Curriculum Project?

The ISWEC project has as its goal the development of a comprehensive, integrative framework in which all of the standards described above are located. The project is also developing and refining a process for curriculum development using standards. The ISWEC project is premised on the need to have the standards examined and integrated in a comprehensive way. Thus, although teachers have a vital role in curriculum planning, the burden of curriculum development cannot be placed primarily on teachers. The problem of finding the time and resources to participate in large-scale curriculum initiatives is almost universally cited by teachers and administrators. Another premise of the ISWEC project is that employers need to have a voice in curriculum planning. Again, for educators to find the time and resources to identify, recruit, and work with employers is a very big obstacle in many states and districts. The ISWEC project can support the curriculum development efforts of local educators by providing a framework based on the interests of representative groups from the academic disciplines and business and industry. Local groups as well as individual teachers can then use the framework as well as the process to develop programs that are suited more closely to their local needs and strengths.

What Is an Integrated Curriculum Standard, or ICS?

The initial focus of the ISWEC project has been the development of a new type of standard—the Integrated Curriculum Standard (ICS)—which is synthesized from standards in the three areas—workforce or skill standards, academic standards, and general employability standards. By synthesizing the standards in these separate areas from the beginning, the ISWEC project will provide the basis for a truly integrated curriculum framework.

An ICS is a standard, a statement of expectation for performance, one that integrates workforce competencies, academic content, and employability standards. ISWEC organizes ICSs in such a way that benchmarks, guidelines, and rubrics to support authentic assessment are incorporated.

Examples of two Integrated Curriculum Standards (in draft form) are shown in Appendix A. Each ICS is followed on the next page by a table, which is, in effect, a working document that lists all the standards that were incorporated into this particular ICS, with their identifying groups and numbers. The first ICS shown is based on performance of a practical task—sampling—but the emphasis of the standard is on the broad concept of sampling and its significance within the system in which it is used. The second ICS is based on a body of knowledge about chemical bonding linked to a fundamental tool used in chemistry, the periodic table.

Some ICSs, such as the one shown on sampling, will define performances—tasks—but the emphasis in each of these ICSs will be different from that in a task list. In an ICS such as the one shown on sampling, the emphasis will be on higher-order thinking skills, on the transferable aspect of the task, and on the significance of the task within an entire system.

Many other ICSs, such as the one on the periodic table, will relate bodies of knowledge, but the emphasis in each of these ICSs will be different from the emphasis in a traditional text or lecture. In an ICS such as the one on the periodic table, the emphasis will be on the higher-order thinking skill involved in using a body of knowledge, on the contexts in which this knowledge can be applied, and on information retrieval as much as on the information itself.

How Will ICSs Be Grouped into Clusters and Career Majors?

Many Integrated Curriculum Standards are expected to be developed at the broad level reflected in the examples in Appendix A. The broad-based ICSs will form the knowledge and skill base that should be addressed across an entire cluster of career majors. Other ICSs will address knowledge and skills at a more specific, career-major level. Still others will address tasks specific to the occupational specialty. The order, from general to specific, is as shown below.

Career Cluster, e.g., Business, Marketing, and Management

Career Major, e.g., Administrative Support

Occupation, e.g., Executive Secretary

For example, an ICS eventually will be developed that addresses specific skills required for sampling in chemical processing plants. The broad concept of sampling will have been learned at an earlier point and can be referenced easily as the occupationally specific skill is taught, most likely at grade thirteen or fourteen. The broad concept experienced in high school also will provide a meaningful departure point for students who pursue baccalaureate degrees after high school.

The development of both broad and specific ICSs addresses several educational issues raised by participants in school reform including the following: introduction of the relevance of work early enough in the educational process to avoid losing or alienating students;[11] instruction at a level broad enough to be transferable to complex, real-world problems;[12] and instruction at a level specific enough to develop occupational skills leading to employment.[13]

What Is the Role of Assessment in the ICS Framework?

In the ICS framework, assessment is considered an integral and ongoing part of the teaching and learning process. Assessment is defined in the ISWEC project as a description of specific performance without placing a value on results. Assessment is a collection of data with regard to knowledge, skills, and attitudes, that includes prespecified characteristics and/or agreed-upon units of measurement. Assessment addresses both the process and the product involved in meeting a standard. Authentic assessment is the collection of data in the context of and consistent with the Integrated Curriculum Standards.

Assessment is distinguished from evaluation, which is the interpretation of assessment data that includes a judgment based on specified criteria. In the ISWEC project, assessment/evaluation rubrics will have three primary functions. The rubrics will:

1. identify the components of the Integrated Curriculum Standard,
2. describe the criteria related to the product or process about which data must be collected, and
3. state clearly the expected quality of performance serving as the benchmark for the standard.

In the ISWEC design, assessment rubrics and structures will be included to support teachers and students in gathering data for self-evaluation and evaluation of student performance by teachers, instructional decision making, and monitoring of the teaching and learning processes by both the students and the teacher. Appendix A includes a rubric for one of the three components of the ICS on sampling.

How Can ICSs Be Used to Develop Curricula?

Traditional approaches in curriculum design are based on subject-matter courses designed independently, with integration attempted retrospectively. This process results in great resistance to changes in content or methodology. The ISWEC project is undertaking the integration of academic, vocational, and employability standards before commitments are made to specific course structures. In this process, the value of each area of curriculum content (academic, occupational, and employability) is acknowledged, and the practice of advocating one area to the exclusion of others is being abandoned. This process is a response, in part, to the consortium's concern that the ISWEC framework not resemble a patchwork quilt. Using the ICS concept, the synthesis of curricula will instead resemble a woven fabric.

The standards that have so far been put into the ISWEC database are for the most part based on standards developed by groups at the national level. However, other standards could be added, including data for additional occupations or state or local requirements. The methodology is being refined to permit the use of computerized listing of the standards so that manipulation and organization are possible. As mentioned previously, the process for working with the standards is an important project deliverable.

Because ICSs are by nature modular and lend themselves readily to project-based learning, the curriculum structures to be used with ICSs are open-ended. Traditional courses can incorporate a set of ICSs, but other structures such as project-based courses, team teaching of selected ICSs across the disciplines, and worksite learning will also be possible.

ICS sequencing will be built into the framework. Each ICS will have indicated its level of specificity; that is, whether it is considered to fit best at the cluster, major, or occupational specialty level. Any other ICSs considered prerequisite will also be indicated. Some ICSs will not have prerequisites. Using this information, curriculum planners will be able to sequence and group the teaching of ICSs as they see fit, according to the needs of students and the strengths of their programs.

What Process Is Being Used to Develop the ICS Framework?

Some parts of the ICS development process have been discussed here. Appendix B lists steps being used to develop the ICSs. The process is being refined and streamlined as the ISWEC project continues, but it is believed that like most curriculum integration processes, as documented by Drake, Jacobs, Perkins, and others, it will remain recursive and somewhat open-ended. Thus the ISWEC project has in place a number of checks and balances on the process and the products. Many of the ICSs developed so far have been produced in-house by curriculum specialists. However, the project is poised to bring in teams of highly qualified academic and vocational teachers and industry representatives to work on the next stage. Members of the Integrated Assistance Network will review work as it is completed. ISWEC project deliverables, including the implementation guide, will be pilot-tested beginning in 1997.

What Is the Relationship Between Integration and Higher-Order Thinking Skills?

One of the most exciting breakthroughs in this work on the Integrated Curriculum Standards has been a growth of understanding of the crucial role of metacognition, or reflective learning, in integrating vocational and academic education. Reflective learning involves the conscious consideration on the part of learners of their own thinking processes. Current research in learning theory generally, and in vocational education specifically, indicates that if students are to learn in a manner that is transferable to new and unfamiliar situations, they must learn and be taught at the metacognitive level. That is, they must learn to think about the thinking processes they use to solve problems, to carry out certain tasks, to evaluate situations. Such reflective learning does not depart from the emphasis placed on contextual learning in vocational and technical education;

rather, it expands on the use of real-world problems and problem-solving strategies. Some areas of focus within content areas in vocational and technical education—for example, troubleshooting in manufacturing or processing systems—involve thinking strategies that have traditionally been undervalued or lacking in the teaching of academic disciplines. At the same time, some of the thinking strategies often taught within academic content areas, such as use of the scientific method, are important tools for problem solving in the workforce.

In the process of synthesizing workforce, employability and academic standards, we hope to find the meeting place for the teaching of these highly transferable cognitive skills. In addition, research supports us in the notion that an emphasis on problem-solving and other thinking skills, especially metacognition or thinking-about-thinking skills, reinforces retention and meaning within content areas.

A Final Comment

The Integrated System for Workforce Education Curricula project will result in a system by which state and local educational entities can effectively integrate curricula and teaching methods that address the changing workplace.

The system will offer career-preparation pathways that:

- **are organized around career clusters**, which are occupations or groupings based on common core competencies;
- **are built on workplace and employability standards** validated by business, industry, and labor, and **academic standards** that assure students of a firm educational base;
- **build on a strong foundation** of contextual, cognitive, and work-related skills by integrating academic and technical education;
- **prepare learners for an ever-changing work world** via the enhanced transfer of cognitive and technical skills across multiple occupations;
- **include authentic assessment components** that verify what a job seeker actually knows and can do in relation to the standards; and
- **provide for multiple exit points** to work and reentry points to career preparation from high school through an associate degree

While the ISWEC project is concentrating on issues of curriculum reform, many other organizations are working in their respective areas to make changes necessary to foster systemic education reform. Educational guidance organizations and the counselors they represent are meeting to make changes in the guidance process needed to present students the workforce information they require to make informed academic and career choices. Organizations concerned with assessment have been examining changes needed to measure student success in obtaining the knowledge specified by the standards. Other research organizations are studying critical issues such as teacher training and school restructuring to improve educational delivery. As new educational delivery structures, such as employer-operated systems for continuous training and just-in-time training, emerge, new relationships between businesses and higher education institutions are being forged. Higher education institutions and the professional organizations associated with them are studying their role in education of students for society and the workforce. Education organizations involved in advising public policymakers are also working to develop recommendations for changes in public policy needed to foster and bring about education reform.

Systemic education reform will occur only when each area effecting education is represented in the decision-making process. This paper expresses a position on curriculum reform for the purpose of providing a point of reference for others interested in ongoing discussion on the components and changes needed to bring about systemic education reform.

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[1] Jobs for the Future, *Revitalizing High Schools: What the School-to-Career Movement Can Contribute*, Washington, DC: American Youth Policy Forum et al., 1995, page 1.

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Appendix A

Sample Integrated Curriculum Standards

This document was prepared for the Integrated System for Workforce Education Curricula Consortium by the Center for Occupational Research and Development, and is a draft issued for information purposes on April 9, 1996.

ICS #001 Sampling concepts and procedures

Description of ICS #001:

Demonstrate the use of proper procedures for sampling in a given natural and a given industrial environment. Obtain representative samples and document according to established industry and agency procedures and regulations. Articulate an understanding of the concept of representative sampling and its role in supporting the statistical claims for purposes such as environmental assessment, process control, or quality assurance/quality control.

Components of the ICS for Rubric Development:

- Use of sampling procedures
- Verification of sampling procedures
- Articulation of the application of sampling

Rubric for the component, "Use of Sampling Procedures" in ICS #001:

4 - World Class Learner

Consistently obtains representative samples according to specified industry or agency procedures in such a precise manner that the variable being monitored is accurately reflected. Thoroughly and accurately records the conditions of sampling, including but not limited to, such conditions as time of sampling, location of sampling, extenuating environmental circumstances, and initial observation of the sample.

3 - Proficient Learner

Consistently obtains representative samples according to specified industry or agency procedures in such an acceptable manner that the variables are being monitored with a high degree of accuracy. Accurately records the minimum conditions of sampling. Related and extenuating conditions are sometimes ignored.

2 - Developing Learner

Occasionally obtains representative samples according to specified industry or agency procedures in such a manner that the variables are being monitored with an inconsistent degree of accuracy. Documentation is superficial.

1 - Emergent Learner

Rarely, if ever, obtains representative samples consistent with specified industrial and agency procedures. Samples, if obtained, do not reflect accurately the condition being monitored. Documentation is incomplete or inaccurate.

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SAMPLING

PRIMARY SOURCES Employability	Business/Industry	Academic	K S A	I CS Ref. #	ELEMENTS OF STANDARDS
		AAAS-230.09D.7	K	a	The larger a well-chosen sample of a population is, the better it estimates population summary statistics. For a well-chosen sample, the size of the sample is much more important than the size of the population. To avoid intentional or unintentional bias, samples are usually selected by some random system.
*		AAAS-300.12E.1	S	a	Notice and criticize arguments based on the faulty, incomplete, or misleading use of numbers, such as instances when (1) average results are reported, but not the amount of variation around the average, (2) a percentage or fraction is given, but not the total sample size (as in "9 out of 10 dentists recommend..."), (3) absolute and proportional quantities are mixed (as in "3400 more robberies in our city last year, whereas other cities had an increase of less than 1%), or (4) results are reported with overstated precision (as in representing 13 out of 19 students as 68.42%).
*		NCTM-167.10.4	K	a	Understand sampling and recognize its role in statistical claims.
	ABT-19.08		S	a	Analyze/evaluate experimental conclusions, conflicting data, controls, data, inferences, limitations, operational questions, replications, samples, sources of errors, variables.
	BS-A-08		S	a	Return, archive, or dispose of samples.
	BS-B-08		S	a	Obtain, process, and store product samples (applies to all manufacturing steps).
	BS-C-02		S	a	Match request to test sample.
	BS-C-04		S	a	Obtain and label sample/specimen.
	BS-C-05		S	a	Handle, transport, store sample, including legal requirements.
	BS-F-05		S	a	Sample environment.
	CLT-27.26		S	a	Obtain representative samples.
	CLT-29.12		S	a	Select containers, and prepare and store samples and materials in compliance with both regulations and compatibility.
	CLT-29.13		S	a	Label all samples and chemical materials with information containing chemical name, formula, toxicity, date stored, expiration date, appropriate symbols, and other pertinent information.
	CLT-29.14		S	a	Store samples and chemical materials.
	CLT-29.17		S	a	Develop a material and sample inventory database and schedule.
	CLT-29.23		S	a	Prepare samples for shipment in compliance with employer's shipping and receiving rules and regulations.
	CLT-29.B			A	SAMPLE AND HANDLE CHEMICAL MATERIALS. (Header for 29.12—30.19)
	CLT-30.12		S	a	Prepare materials and/or samples for shipment or transport to other laboratories.

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PRIMARY SOURCES			K S A	I CS Ref. #	ELEMENTS OF STANDARDS
Employability	Business/Industry	Academic			
	CLT-30.15		S	a	Apply knowledge of stability and shelf-life to the selection of storage containers and maintenance of chemical inventories and sample libraries.
	CLT-30.16		S	a	Design and implement a sample-storage system, with inventory control.
	CLT-31.01		S	a	Obtain representative samples.
	CLT-31.16		K	a	Describe how to collect samples to represent bulk materials to be characterized by physical tests.
	CLT-31.19		S	a	Obtain representative samples.
	CLT-32.01		S	a	Make observations regarding condition of sample and record any notable characteristics.
	CLT-32.17		S	a	Use a variety of sampling procedures and select the proper procedure to sample a bulk material.
	CLT-33.11		K	a	Select the techniques and devices appropriate for specific samples and accuracy requirements.
	CLT-34.01		S	a	Obtain representative samples.
	HMT-14.01A		K	a	Identify and describe the safe and proper use of equipment such as: drum crushers, hand tools, heavy equipment, monitoring and sampling equipment and instrumentation, motorized lifting devices, power tools, pumps, valves, and meters.
	HMT-15.01C		S	a	Operate gauges, meters, and monitoring and sampling instrumentation.
	HMT-17.01			a	Job Function (K): Collect, prepare, document, and ship samples for analysis.
	HMT-17.01D		S	a	In accordance with instructions and/or procedure, collect samples such as: air and soil, bulk materials, groundwater, solid wastes, and surface water.
	HMT-17.01E		S	a	Identify and demonstrate an ability to adjust procedures appropriately for potential sample interferences.
	HMT-17.01G		K	a	Identify and describe the appropriate use, limitations, and applications for sampling equipment such as: colorimetric indicator, combustible-gas indicator, and organic-vapor analyzer.
	HMT-17.01I		S	a	Prepare and ship samples to laboratory.
	HMT-18.01B		S	a	Follow appropriate plans such as: assessment plan, health and safety plan, initial sampling plan, remediation plan, risk-assessment plan, site-closure plan, standard operating procedures, and waste-minimization plan.
	PTO-46.10		S	a	Collect appropriate samples.
	PTO-46.12		S	a	Submit samples for analysis.
	PTO-47.07		K	a	Describe when, where, and why samples are taken for analysis and how the sampling techniques relate to quality products.
	PTO-47.19		S	a	Collect appropriate samples.
	PTO-47.21		S	a	Submit samples for analysis.

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PRIMARY SOURCES			K S A	ICS Ref. #	ELEMENTS OF STANDARDS
[illegible]	Business/Industry	Academic			
	PTO-50.10		S	a	Follow specified procedures to collect appropriate samples for analysis from process streams or products (solids/liquids/gases).
	PTO-50.11		S	a	Visually inspect samples to ensure adequate representation of the sampled materials, and determine if any immediate response is required.
	PTO-50.12		S	a	Label samples appropriately and according to any prescribed procedures.
	PTO-50.13		S	a	Deliver samples in a condition representative of the material to testing locations.
	PTO-51.03		S	a	Prepare proper paperwork to submit samples to the laboratory.
	PTO-51.05		S	a	Describe procedures for obtaining representative samples of solids, and demonstrate use of appropriate techniques.
	PTO-51.06		S	a	Describe sampling devices for use with gases under pressure, and demonstrate how to use typical sampling devices.
	PTO-51.07		S	a	Sample a flowing liquid stream.

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ICS #004 PERIODIC TABLE/BONDING/STRUCTURE OF MATTER

Description: Use the periodic table to learn about and predict the properties of elements based on their atomic structure and bonding characteristics. Correlate the position of elements in the table to the following: 1) their atomic structure; 2) the way they bond to one another and to other elements based on their atomic structure; and 3) the way these bonding characteristics affect their properties. Use chemical handbooks, databases, and other resources to verify the properties as determined by the periodic table and, where appropriate, further correlate those properties to their location on Earth and the benefits and hazards associated with them.

Prerequisite: none

Project ideas:

- Multimedia Periodic Table game in which students get an overview of the Periodic Table, then have to predict properties of materials using first, only the table, then confirming with their desk references, databases, or on-line resources.

- The World as We Know It! A survey of basic elements used in local industries, with preliminary predictions made based on periodic table, and investigation made of properties, uses, shipping, and handling considerations/restrictions, sources, and markets of elements produced or received and used, and so on.

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PERIODIC TABLE/BONDING/STRUCTURE OF MATTER

PRIMARY SOURCES Employability	Business/Industry	Academic	K S A	ICS Ref. #	ELEMENTS OF STANDARDS
	ABT-19.05		S	a	Use the periodic table.
		NSTA-042.C1.2	K	a	An element is composed of a single type of atom. When elements are listed in order according to the number of protons (called the atomic number). repeating patterns of physical and chemical properties identify families of elements with similar properties. This "periodic table" is a consequence of the repeating pattern of outermost electrons and their permitted energies. Chemistry—The Structure and Properties of Matter
		NSTA-042.C1.2a	K	a	Understand concepts (9th): chemical family, periodic table, metal, nonmetal, nonmetalloid.
		AAAS-114.05C.8	K	b	A living cell is composed of a small number of chemical elements mainly carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur. Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms in chains and rings to form large and complex molecules.
		AAAS-251.10F.4	K	b	While the basic ideas of Lavoisier and Dalton have survived, the advancement of chemistry since their time now makes possible an explanation of the bonding that takes place between atoms during chemical reactions in terms of the inner workings of atoms.
	ABT-19.02		K	b	Describe/explain electrons in general, in chemical bonding, covalent bonding, electric charges, ionic bonds.
		NSTA-049.C1.6	K	b	Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life. Chemistry—The Structure and Properties of Matter
		NSTA-070.B1.2a	K	b	Understand concepts (9th): energy, matter, chemical reaction, synthesis, metabolism, anabolism, catabolism, molecules, energy bonds, enzymes, light, wavelengths, pigments, carbohydrates.
		NSTA-075.B2.1b	K	b	Understand concepts (10th-12th): bond energy, energy molecules, ATP, oxidation-reduction, limiting factors, range of tolerance, quality of light.
	CLT-35.05		S	b	Describe the common features of structural analysis of inorganic and organic materials (e.g., crystallinity, functional groups, bonding, and so on).

PRIMARY SOURCES Employability	Business/Industry	Academic	K S A	ICS Ref. #	ELEMENTS OF STANDARDS
		NSTA-075.B2.1	K	b	The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and lower energy bonds are formed in new compounds. Cells usually store this energy temporarily in phosphate bonds of a small high-energy compound called ATP. The energy for life ultimately derives from the sun. Plants capture light energy and use it to form strong (covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. These molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars, and fats). In addition, the bonds between the atoms can be used as sources of energy for life processes. The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle organic materials. Biology—Matter, Energy, and Organization of Living Systems
		AAAS-080.04D.1	K	b	Atoms are made of a positive nucleus surrounded by negative electrons. An atom's electron configuration, particularly the outermost electrons, determines how the atom can interact with other atoms. Atoms form bonds to other atoms by transferring or sharing electrons.
		NSTA-044.C1.3	K	b	Atoms interact with one another by transferring or sharing electrons that are farthest from the nucleus. These outer electrons govern the chemical properties of the element. Bonds between atoms are created when electrons are transferred or shared. A substance composed of a single kind of atom is called an element. The atoms may be bonded together into molecules or crystalline solids. When two or more kinds of atoms bind together chemically, a compound is formed. Chemistry—The Structure and Properties of Matter
		NSTA-044.C1.3b	KK	b	Understand concepts (10th-12th): molecular formula, empirical formula, percent composition, electron transfer, electron sharing, ionic bonds, covalent bonds, Lewis dot diagram, valence electrons, cations, anions, bond energy, electronegativity, bond strength.
	ABT-19.06		K	c	Recognize basic functional groups and the common chemical reactions in which they are involved.
		AAAS-080.04D.6	K	d	When elements are listed in order by the masses of their atoms, the same sequence of properties appears over and over again in the list.
		AAAS-080.04D.8	K	d	The configuration of atoms in a molecule determines the molecule's properties. Shapes are particularly important in how large molecules interact with others.
	HMT-20.02		S	d	Use chemical handbooks to determine the chemical and physical properties of elements and substances.
	HMT-20.19		K	d	Identify the hazardous properties of common chemical elements in terms of their toxicity, flammability, corrosivity, or reactivity.
		NRC-176.B2	K	d	Structure and properties of matter

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PRIMARY SOURCES Employability	Business/Industry	Academic	K S A	ICS Ref. #	ELEMENTS OF STANDARDS
		NSTA-040.C1.1	K	d	Matter as found in nature, consists primarily of mixtures, compounds, and elements in various proportions. The observable properties of mixtures depend upon the nature of the components. A mixture can be separated into pure substances using the characteristic properties of the substances contained in the mixture (implied by but not explicitly stated in Standards document). Chemistry—The Structure and Properties of Matter
		NSTA-045.C1.4	K	d	The properties of compounds reflect the nature of the interactions among their molecules, which are determined by the structure of the molecule (the kinds of atoms, and the distances and angles between them). Chemistry—The Structure and Properties of Matter
		NSTA-059.C3.1	K	d	Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atom together. Chemistry—The Structure of Atoms
		NSTA-114.ES2.1	K	d	The Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and living things as part of geochemical cycles. Movement of matter between reservoirs is driven by the Earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of matter. Carbon, for example, occurs in rocks as limestone, in the atmosphere as a gas, in water as dissolved carbon dioxide, and in all living things as complex molecules that control the chemistry of life. Earth and Space Science—Geochemical Cycles
*	CLT-25.05		S	d	Search database for properties of materials.
	PTO-46.18		K	d	Describe the major industrial continuous processes by (1) describing the characteristics of each, (2) the chemical/physical properties of materials important to the operation, (3) the environmental regulations and safety concerns that are related to each operation, and (4) how the operations usually are interrelated.
	PTO-48.02		K	d	Describe the major industrial batch processes including common chemical, refinery, water, and waste treatment processes by (1) describing the operation of each; (2) characterizing the chemical/physical properties of materials that are important to the processes; (3) writing the molecular formulas and chemical structures for substances involved in the processes; (4) describing the chemical reactions involved in each process; (5) describing the chemical equilibrium, kinetics, and chemical reactivity relationships that characterize the processes or may impact safety; and (6) identifying relevant environmental regulations and safety concerns.

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Appendix B

Steps Toward Integration Using Workforce, Academic, and Occupational Standards

This document was prepared for the Integrated System for Workforce Education Curricula Consortium by the Center for Occupational Research and Development, and is a draft issued for information purposes on April 9, 1996.

Steps Toward Integration Using Workforce, Academic, and Occupational Standards

1. Identify potential themes through an eye search—based on the frequency of occurrence—of tasks, concepts, principles, knowledge bases, or reflective thinking required.
2. Run a computer word sort of the list of standards using several descriptors.
3. Eliminate obvious outliers.
4. Identify major subcategories based on major concepts, skills, attitudes, and knowledge bases.
5. Observe the Knowledge/Skills/Attitude classification to clarify major subcategories.
6. Cross-check the list of subcategories against SCANS competencies: Information—Resources—Technology—Interpersonal—Systems.
7. Identify/select the theme of the Integrated Curriculum Standard(s) that can be derived from this set of standards. Identify deep features.
8. Use guiding questions:
   a) What do I need to know?
   b) What do I need to know how to do?
   c) What thinking processes do I find myself using as I learn this information?
9. Write intermediary competencies that combine several or many standards.
10. Write the ICS and assessment.

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ISWEC and the Curricular Structure

The Integrated Curriculum Standard (ICS) framework will provide the basis for organizing curricula into one or more of several structures. By its nature, the ICS framework is extremely flexible. For example, a cluster-level ICS—one that addresses skills in oral communication—could be integrated into a larger curriculum in several different ways. It could be:

- infused into a conventional English course, providing the basis for a project within the course; the rubric that goes with the ICS would be the assessment tool for the project.
- used as a bridge between two existing courses. For example, an English teacher and a physics teacher might team teach a project on oral communications in physics: how to present complex physics concepts clearly and understandably.
- combined with other cluster-level ICSs to create a new across-cluster and cluster-level course in communication. The course might include oral and written communications in a variety of contexts.
- combined with other cluster-level and career-major-level ICSs to create a new career-major-level course in communication, one that focuses on the types of occupational situations typical in that career major.
- used as the basis of a minicourse related to a single occupational specialty. In a specialty on air conditioning and refrigeration, for example, it could be the basis for a minicourse on "explaining problems to the customer."
- combined with many other ICSs to develop an integrated semester "theme course" to be addressed by all teachers at a particular grade level, for example, a theme course on "transportation" or on "change."

The flexibility of the ICS framework in terms of structure is one of its assets. The framework connects to the world of work, but it does not dictate to schools precisely which route to take to get to a given career. It is anticipated that most schools will want to pursue the first option above—infusion into conventional courses. For these schools, the project will provide a scope and sequence for use in this manner. However, through field-testing, it is expected that other models with distinct advantages will emerge. Moreover, a given ICS may lend itself to certain approaches and, when examined in conjunction with its assessment rubric, may suggest possible instructional strategies and curricular organization. For example, an ICS on chemical reactions may specify another ICS on the periodic table as a prerequisite. An ICS on sampling may be accompanied by a rubric that includes a benchmark for explaining the concept of sampling and that references other ICSs on communication.

In addition to the scope and sequence component discussed above, the project will provide educators with the following resources in at least three cluster areas.

- detailed cross-references that show the integrated linkages among the various parts of the curriculum and traditional subject areas. This information will provide teachers with extensive information for use in delivering contextual education in all areas of the curriculum.

- outlines, descriptions, and reference materials for the portions of the curriculum that address the employability and occupational aspects of the curriculum, particularly in math, science, communications, and technical skills.
- recommended curriculum structures incorporating both traditional and nontraditional methods for implementing integrated curricula.
- implementation guides for the curriculum-development model and the specific prototypes.

The curriculum map that follows, shows the major components that will be included in the plan of study for a cluster. Much of the curriculum will be built on contextualized courses and project-based learning in many forms. In these areas, the ICS structure will result in extensive integration of academic and workplace knowledge, skills, and attitudes. At the extremes of application learning on one hand and abstract learning on the other, will be smaller but important parts of the curriculum that will provide the student with preparation for applied and abstract study. In this model, students are motivated through concentrated exposure to integrated learning early in the program and then build a strong combination of academic preparation and work readiness as they progress and mature.

ISWEC CURRICULUM MAP